Original Article

Elite coaches' approach to quantifying technical actions and relative participation in volleyball players' performance

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ABSTRACT

This study sought to identify elite coaches' perception of the importance of technical actions and the consideration of relative participation to measure individual volleyball players' performance. An instrument was elaborated to gather the opinions of elite coaches on the importance of technical actions reported by the data volley (excluding setting), as well as considering relative participation. Twenty elite coaches with at least three years of experience in national teams or top leagues participated in the study. Variables considered in the study were analysed using descriptive statistics and reliability was measured with Cronbach's α and McDonald's Omega coefficients (> .70). The results assessed the importance of scoring actions, which received values of (1 point). All errors (terminal and continuity) were scored with (−1). Non-scoring actions were given values [.00, .80], except for poor attack (−.35), poor serve (−.60), free freeball (−.60) and reception free (−.50). Relative participation was considered according to the percentage of points and/or contacts played by each athlete. We concluded that for the player's points and/or contacts, priority is given to actions that win points directly or are excellent, followed by those that contribute to building comfortable attacks, while penalising errors.

Keywords: Performance analysis of sport, Terminal actions, Continuity actions, Individual performance, Box score.

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INTRODUCTION

Match analysis is an approach that is of interest in professional sport to win and achieve records (Marmarinos, 2019), but also as a desire to identify the best player or who made the biggest contribution to winning (Terner & Franks, 2021).

Initially, match analysis was descriptive; every player's actions during a game were recorded and then synthesised into the box score (Burroughs, 2018). Charts were developed with each player's individual production shown in absolute frequencies (e.g. points per player), with their productivity, shown in relative frequencies using simple mathematical formulas (e.g. percentages, efficiency, or ratios) (Terner & Franks, 2021). The use of valuation coefficients or indexes based on these box scores has become popular; examples include the Wins Above Replacement (WAR) in baseball (Duquette, 2019), the Player Efficiency Rating (PER) in basketball (Kubatko et al., 2007), or the FIVB scale of the Fédération Internationale de Volleyball, among others. These systems are linear weightings of all actions performed, which simplify each player's performance into a single number.

New digital technologies have amplified the capacity to register, process, store and even analyse great amounts of data in real time (Araújo et al., 2021). This has caused a shift in the investigation of play analysis towards more predictive analyses that seek to determine the connection between actions or their relationship to victory (Chen et al., 2021; Fernández-Echeverria et al., 2017). Coaches continue to use new technologies with descriptive purposes, given that, on many occasions, science cannot solve the real problems of play (Lyle, 2018). Scoring actions (i.e. goals, points, trials) are the main indicator for sport performance, given the huge relationship with victory (Drikos et al., 2021). However, there are prior interventions that help scoring actions, such as basketball assists or football or volleyball passes, and these are difficult to quantify (Benavente & Vilar, 2009). How much are these actions worth?

Data Volley software has become the tool generally used among volleyball coaches to measure the player performance in competition. Data volley makes it possible to personalise the descriptive analyses and even to export the data for other types of analysis (Data Volley, 2010). It yields quantitative reports, shown in the box score, that are of great use for coaches and are available in each set (Zetou, 2007). These quantitative reports create a certain amount of confusion because they use different metrics depending on the action analysed (Franks et al., 2016). The performance of all scoring terminal actions, for example, is mainly valued in points scored, and any wrong action is easily translatable to points given to the rival. Continuity and terminal actions that do not manage to score, however, are expressed in relative terms, fundamentally by efficiency percentages (Palao et al., 2004). This generates controversy, because it effectively silences or undervalued the contributions of players who do not score directly, which makes comparison of these players with directly scoring players quite difficult (Duch et al., 2010). The sequential character of volleyball means that the success of terminal actions is conditioned by the quality of the continuity contacts (Nikos et al., 2009). Indeed, teams include players in their rosters who specialise in these types of actions (i.e. the libero, or specialist in receiving or defensive roles) (Valladares et al., 2016).

Measuring the individual contribution of each player is fundamental in sport, and it is done with a business purpose that is assimilated with a cost/benefit production process (Sánchez et al., 2007). Determining the contribution of each player according to his/her participation appears to be the intention of using mathematical formulas such as efficiency (Zidane & Olson, 2017). The relative participation of each player (e.g. time played, ball contacts) thus affects his/her play contribution (Lee & Worthington, 2013). The challenge in relative participation consideration is finding the variable that best shows the contribution of each player, because

measuring according to minutes/points played or contacts made will condition its values. Seldon (1999) found that no data are trustable on their own, but that the combined use of relative and raw data is the most useful.

In volleyball it is usual to consider the relationship between the relative participation of the player with the total amount of contacts (Giatsis et al., 2022). This helps to clarify the quality of all his/her contributions but does not assess the grade of participation within the team. Incorporating the relative participation in proportion to the total amount of points played by each player would avoid skewing the performance of those players who participate less (Bisagno et al., 2019; Valladares et al., 2016).

Volleyball coaches base many decisions in competition on quantitative analyses reported with data volley (Silva et al., 2016). but each coach personalises and relativises the analyses according to his/her interests, making comparison impossible (Palao & Hernández-Hernández, 2014). It would thus be of useful for coaches to share standardised values (Miskin et al., 2010), which include continuity actions that can be integrated in a unique reference value.

This study therefore sought to identify elite coaches' perception of the relative importance of technical actions and relative participation for measuring the performance of individual volleyball players in competition.

MATERIAL AND METHODS

Variables and instruments

Four university professors and coaches who specialise in volleyball and have at least five years of experience in both areas elaborated an instrument to gather the opinion of the world's elite coaches. The instrument explores the opinions of elite coaches on the importance of technical actions and the consideration of relative participation for measuring individual performance in competition. The mentioned instrument forms a part of a larger Project (Doctoral Thesis), in which, complementarily, the trainers' opinion is considered on the contextual variables frequently considered when investigating volleyball. The instrument consists of two parts, each of which corresponds to one of the variables considered in the present study:

1) The variable on the importance of technical actions, understood as a value (between +1 and −1, in intervals of 0.1) awarded by elite coaches to the different categories considered in the data volley for each technical action (Table 1), but excluding setting due to its complexity and singularity. Three terminal actions are considered: serve (S), attack (A) and block (B); three continuity actions are also considered: reception (R), dig (D) and freeball (F), which is received explicitly by the software as a given dig. The six technical actions are categorised according to six codes used by the software #, +, !, −, / and = (i.e., S#, S+, S!, S−, S/ and S=).
2) The variable considering relative participation is understood as whether or not it is necessary take into account this variable to measure the individual performance of volleyball players in competition, and if so, how to value it. An initial dichotomous question (YES or NO) is included on the convenience of measuring player performance with this variable. If affirmative, the experts are asked to suggest the most convenient of two options: (a) points played by each player relative to the total; or (b) three ranges according to tertiles of points played. This section included an open-ended question for which experts could note down comments or suggestions.

The world's elite coaches were contacted directly, asking for their participation and offering all the information. All the trainers who agreed to participate received an online link to the online platform SurveyMonkey where the instrument was hosted for month. Prior to the final closing of the platform, two flow-ups were sent at seven and three days.

Table 1. Codes and definition of the efficiency of technical actions in volleyball included in the research as collected by data volley.

		SERVE (S)
S#	Ace	Direct serve, the opponent cannot receive and loses the point.
S/	Free	Bad reception. The ball is sent directly to the other court o it cannot be attacked.
S!	Right	Opponent receives and has a chance to a first-time attack only with a high risk
S+	Positive	Opponent makes a negative reception and can only attack a high ball.
S-	Poor	Opponent makes an excellent reception and can attack any combinations, quicks.
S=	Error	Serve error (Opponent wins the point directly).
		ATTACK (A)
A#	Kill	Attack Kill.
A/	Blocked	Blocked attack (the opponent wins the point).
A!	Recovered	Blocked Attack (recovered by the teammates' coverage).
A+	Positive	Defended attack with difficulty by the opponent not allowing combination plays.
A-	Poor	Negative Attack (defended by the opponent that can attack in combination).
A=	Error	Error (out, net touch or crossing the court centreline).
		BLOCK (B)
B#	Kill	Block Kill.
B/	Invasion	Block Net Fault
B!	Right	Recovered by the opponent defence for a counterattack.
B+	Positive	Positive or Passive Block (recovered by the local defence for a counterattack).
B-	Poor	Block touch (the opponent's defence does not allow a counterattack.)
B=	Error	Error (block out)- the opponent wins the point.
		RECEPTION (R)
R#	Excellent	Excellent Reception (it allows combination attacks, quicks...).
R/	Free	The balls go directly to the opponent's court and/or not allow to attack.
R!	Right	It allows to play a first-time attack with a high risk
R+	Positive	Positive Reception (it also allows to play a combination with an extra effort of the setter).
R-	Poor	Negative Reception (it only allows attacks from 4, 2 or back court, not 1st attacks).
R=	Error	Reception Error (the opponent wins the point).
		DIG (D)
D#	Excellent	Excellent Dig (it allows counterattack in combination).
D/	Free	Directly to the opponent's court.
D!	Right	Dig coming from the local defence that allows a counterattack.
D+	Positive	Positive dig (it doesn`t allowed a counterattack in combination, only from 4,2 or back court).
D-	Poor	It does not allow to attack.
D=	Error	Dig Error.
		DIG FREE-BALL (F)
F#	Excellent	It allows the setter to play all combinations.
F/	Free	Free ball defence goes directly to the opponent's court.
F+	Positive	Free ball defence allows to play a combination with an extra effort of the setter.
F-	Poor	Free ball defence does not allow to play first time attacks.
F=	Error	Free ball defence Error (the opponent wins the point).

Participants

The sample consisted of 20 expert judges from the 40 initially contacted (50% response rate), all of them world elite volleyball coaches. They had to have 3 years minimum experience in any of the following criteria: (a) first division coach; (b) national coach; or (c) international competition coach. Regarding the classification used by Swann et al. (2015), international elite coaches were represented by eight elite competitive, eight elite successful and four elite world-class coaches, across three continents. The final selection included elite

international coaches with experience at the Olympic Games, European Volleyball Confederation Champions League or South American Volleyball Championship. These coaches had carried out their work with national teams (e.g. Belgium, USA, Korea, Spain, Colombia or Canada) and also, in parallel, with professional leagues (e.g. Italian, Brazilian, Turkish, Swiss, France, Belgium, Spain, Peru and Greece).

Data analysis

Cronbach's α and McDonald's Omega were used to measure the reliability of the variable importance of technical actions. The reliability in our study was: α = .871 and ω = .876, with α = .806 and ω = .800 for terminal actions and α = .752 and ω = .777 for continuity actions. Cronbach's alpha and McDonald's Omega values above .70 were considered acceptable (Dunn et al., 2013).

The median (Md), mean (M) and standard deviation (SD) were used to describe the variable. Md was used due to its strength for data that does not have a normal distribution (Leys et al., 2013). Consideration of relative participation was analysed through a basic descriptive analysis considering relative and absolute frequency.

The data were analysed using the SPSS v.25 statistical package (IBM Corp., Armonk, NY, USA).

RESULTS

Table 2 shows the descriptive statistics of the importance of all technical actions considered in the studio:

- Terminal actions: integrated by all the actions that target scoring.
  - Scoring terminal actions integrated all terminal actions that involve scoring a point on the scoreboard or losing a point to the rival.
    - Ace (S#), attack kill (A#) and block kill (B#) obtained maximum values of 1 point.
    - Serve, attack and block errors (S=, A=, B=) and block invasion (B/) obtained the maximum negative assessment of −1 point.
  - Non-scoring terminal actions included all terminal actions whose execution does not directly achieve the scoring or loss of a point, so the game continues.
    - Serve free (S/) and positive attack, serve and block (A+, S+, B+), recovered attack (A!), serve right (S!) and poor block (B−) were given positive values [.50 to .80].
    - Block right (B!) obtained a neutral value of 0 points.
    - Poor attack and serve (A−, S−) obtained negative values of −0.35 and −0.40, respectively.
- Continuity actions: integrated all the actions that aimed to neutralise the rival scoring.
  - Scoring continuity actions integrated all the continuity actions whose erroneous execution means losing a point.
    - Continuity errors in reception, dig and freeball (R=, D=, F=), obtained the maximum negative value of −1 points.
  - Non-scoring continuity actions were composed of all the continuity actions that are not erroneous, so the play continues.
    - Excellent serve, dig and freeball were given the maximum value of 1 point.
    - All positive continuity actions, reception, dig and freeball (R+, D+, F+), as well as reception and dig right (R!, D!) were given different positive values under 1 point [.40 to .70].

- All poor continuity actions – reception, dig and freeball (R−, D−, F−) and dig free (D/) – obtained neutral values of 0 points.
- Reception free and freeball free (R/, F/), were given negative values not exceeding −0.5 and −0.6, respectively.

Table 2. Descriptive statistics for the variable on the importance of technical actions.

According to scoring	Technical actions	Denomination	Median	Media	Standard deviation
		Terminal actions			
Scoring terminal actions	S#	Ace	1.00	.98	.09
	A#	Kill	1.00	.99	.07
	B#	Kill	1.00	.99	.07
	S=	Error	-1.00	-.89	.30
	A/	Blocked	-1.00	-.80	.34
	A=	Error	-1.00	-.92	.25
	B/	Invasion	-1.00	-.89	.30
	B=	Error	-1.00	-.76	.43
Non-scoring terminal actions	S/	Free	.80	.73	.24
	A+	Positive	.55	.47	.32
	S+	Positive	.50	.37	.35
	A!	Recovered	.50	.37	.31
	B+	Positive	.50	.52	.30
	B-	Poor	.50	.34	.48
	S!	Right	.20	.13	.44
	B!	Right	.00	.11	.36
	A-	Poor	-.35	-.30	.34
	S-	Poor	-.40	-.36	.42
		Continuity actions			
Scoring continuity actions	R=	Error	-1.00	-.86	.33
	D=	Error	-1.00	-.76	.42
	F=	Error	-1.00	-.93	.25
Non-scoring continuity actions	R#	Excellent	1.00	.94	.11
	D#	Excellent	1.00	.89	.18
	F#	Excellent	1.00	.86	.25
	R+	Positive	.70	.75	.18
	D+	Positive	.50	.57	.23
	D!	Right	.50	.52	.34
	F+	Positive	.50	.31	.48
	R!	Right	.40	.41	.25
	R-	Poor	.00	-.03	.39
	D-	Poor	.00	-.18	.42
	D/	Free	.00	-.21	.39
	F-	Poor	.00	-.12	.46
	R/	Free	-.50	-.53	.35
	F/	Free	-.60	-.55	.47

Regarding the variable consideration of relative participation, the data showed that 14 expert judges (70%) considered it necessary, while 6 expert judges did not (30%) (see Table 3). Among the judges who supported it, 11 (55%) considered it appropriate to measure it in proportion to the points played by each player in the match, while 3 (15%) considered it more appropriate to use three ranges in relation to the points played.

Three expert judges also specified that they would also consider relative participation according to the total contacts in which the player was involved, as is reflected in the following comments:

- "*We must contemplate performance using action frequencies*" (Expert judge 12); *"I would divide according to the contacts in which the player intervened"* (Expert judge 13); and it would be *"better according to the total contacts in which that player participated"* (Expert judge 19).

Table 3. Descriptive statistics for the variable considering relative participation.

Use of the players' relative participation variable?		**N**	**%**	**M**	**Md**	**SD**
Yes		14	70.0	1.30	1.00	.47
	Relative	11	55.0	-	-	-
	Ranges	3	15.0	-	-	-
No		6	30.0	.85	1.00	.67

DISCUSSION

Considering the aims raised in the present study, the experts suggested that the most important technical actions for measuring the individual performance of players in competition are scoring terminal actions: ace (S#), attack and block kill (A#, B#), together with non-scoring continuity actions of excellent quality – reception, dig and freeball (R#, D#, F#). Regarding the relative participation of each player, the experts considered it necessary to adjust the performance according to the percentage of points and/or contacts played by each player.

The results for scoring the terminal actions ace, attack kill and block kill (S#, A#, B#) gained (1) point of value. These results acknowledge that the scoring dynamic concedes one point to the team that executes it (Palao et al., 2004). In this line, Giatsis et al. (2022) pointed out the importance of scoring terminal actions in men's volleyball during several Olympic Games, with it being essential to find a balance among them all. Challoumas & Artemiou (2018) and Silva et al. (2014) found that the attack kill and ace are the best predictors of victories, together with the block kill, which was the most determinant among the top teams in the 2000 Sydney Olympic Games (Palao et al., 2004; Yiannis & Panagiotis, 2005).

Those scoring terminal actions that cause an error that results in the loss of a point reached the lowest valuation of −1 point: serve, attack and block error (S=, A=, B=), or attack blocked (A/) and invasion (B/). These negative values coincide with the scoring of continuity actions that also meant the loss of a point: reception, dig and freeball error (R=, D=, F=). Once again, a scoring dynamic that awards one point to the opponent for each missed action is reaffirmed. In this regard, Drikos et al. (2009) refer to the high penalisation for errors, maintaining that any team aiming for success should achieve three attack kills (A#) for every point missed. Available research indicates that error management is critical to victory, and the appearance of only minor errors is linked with winning teams (Monteiro et al., 2009).

Very uneven values were found for the non-scoring terminal actions, with serve free (S/) given value of (.80) points, which is very close to the value given to all scoring actions. One study found that, in the men's A1 league, the receiving team reached an attack efficiency of 65.45% vs 34.55% for the serving team, which would explain the importance of achieving a serve that provides an advantage to the receiving team and recovers the construction of the attack (Laios & Kountouris, 2010).

Other non-scoring terminal actions that obtained positive values between (.55) and (.50) points were: to positive attack, serve and block (A+, S+, B+) and recovered attack (A!). The attribution of high values by the experts can be explained based on their contribution to increasing the efficiency of terminal actions (Drikos et al., 2009). In this context, Drikos et al. (2021) and Quiroga et al. (2010) emphasise that higher efficiency in terminal actions is the best predictor of winning sets. This prevents rival attacks and makes it possible to gain back the initiative on the construction of attacks comfortably. It noteworthy that poor block (B−) reached a value of (.50) points although it is catalogued as a low quality action and loses the initiative on the attack. This finding suggests the vital importance of blocking in stopping rival attacks (Afonso et al., 2005). Experts thus seem to reward, with half a point, avoiding the loss of a point at the hands of the rival.

In contrast, non-scoring terminal actions were valued negatively by the experts: poor attack and serve (A−, S−) with values of (−.35) and (−.40), respectively. Both situations waste a chance to score, which could favour the easy construction of a rival attack. As Challoumas & Artemiou (2018) argued, low execution levels in terminal actions could be considered as a loss of the attacking advantage, by missing out on scoring a point and favouring rival attacks.

Scoring continuity actions yielded a very interesting result for excellent reception, dig and freeball (R#, D#, F#), which obtained values of (1) point. These results reinforce that, in the coaches' opinion, excellent (#) first contacts would imply an individual player's performance equivalent to any terminal scoring action. These results could be related to the sequential character of volleyball, in which the ability to obtain points is based on the quality of previous actions (Monteiro et al., 2009; Nikos et al., 2009). While we were unable to consult any studies that quantify the value of these actions, they do stand out in relation to excellent reception (Costa et al., 2016) and dig/freeball excellent (Yu et al., 2018) with winning the attack point.

Non-scoring continuity actions that were positively valued by the experts between (0.7) and (0.4) points, were positive reception, dig and freeball (R+, D+, F+), along with dig and reception right (D!, R!). All were considered continuity actions with excellent execution quality that favour many attack options. In general, these results suggest that preventing a rival point (even if a counterattack is not achieved or is yields only limited options) is an indecisive option in the final result of the game but prevents the rival from getting the point in the moment (Monteiro et al., 2009).

Curiously, non-scoring continuity actions poor – reception, dig and freeball poor (R−, D−, F−), as well as dig free (D/) – obtained a neutral valuation of (0) points. These actions imply the easy or direct return of the ball to the rival, facilitating their initiative to generate attacks easily. Due to the attack–defence imbalance in volleyball (Fernández-Echeverria et al., 2015), these results may reflect that momentarily delaying the rival point would balance a disadvantageous situation. It is striking to observe that the experts did not penalise poor continuity actions, but they did negatively assess the wasted poor terminal actions of poor serve and attack. They may possibly be penalised for giving the attack initiative (Monteiro et al., 2009).

Finally, non-scoring continuity actions that obtained the worst valuations (save error) were reception free and freeball free (R/, F/), with values of (−0.5) and (−0.6) points, respectively. These actions involve giving the rival the option to easily build a new attack. Previous studies revealed that the success of teams is determined by the production of a minor number of continuity actions that facilitate the rival building an attack comfortably (Silva et al., 2014).

Regarding the consideration of the relative participation of players, the experts suggested that performance should be measured in proportion to the total number of points and/or contacts played by each player. This

finding is in line with previous investigations that looked to measure the contribution of each player weighted by the number of contacts (Bisagno et al., 2019). This result is also partially in line with previous studies advocating the use of formulas such as efficiency expressed as the difference between the number of won actions minus the lost actions, divided by the total of actions accomplished (Drikos et al., 2009). In pursuit of maximum performance, teams are increasingly specialising their players, which means that players' involvement is not the same in all areas of the game (Marcelino et al., 2008). The role of each player thus influences their share of participation, with the outside attackers being the most involved (Drikos et al., 2020), the opposite spiker players are the most necessary (32.1%) compared to the wing spiker (20.3%) (Araújo et al., 2010). The role in play influences scoring production, and the opposite spiker usually obtains the most points, followed by the wing spiker (Millán-Sánchez et al., 2015).

The results obtained in the present study can help coaches to consider the quantitative importance of each of the technical actions in volleyball and allow comparison of players in different roles. Likewise, the proposed metrics would make it possible to attenuate the actual "*penalty*" of the players who score or participate less (e.g. specialised players in continuity actions such as the libero). This could facilitate greater parity in terms of most valued player (MVP), salaries or public recognition as something separate from the player's role. Although the present study presents a new approach promoting the opinion of expert coaches to establish simple and common metrics, some limitations should be noted. First, using coefficients with a fixed value for each technical action hinders understanding of how they affect dynamic interactions within the game. The individual differences specific of each gender and game role were also not analysed.

CONCLUSIONS

This study showed the importance that elite coaches award to each of the technical actions in volleyball by assigning points to measure the individual performance of players. We conclude that:

- The most important technical actions are those that win points directly or have an excellent execution.
- Obtaining positive ratings, doing technical actions that manage to maintain or recover the initiative to easily build an attack also have great relevance. As an exception, we found that the poor block does obtain a positive value as because its principal target its stopping the rival's previous attack, although it does not allow recovery of the initiative.
- All technical actions that imply the loss of initiative in building an attack and that facilitate the rival in building an attack were penalised with negative ratings.

Finally, individual performance measurement should not refer only to raw scoring data, but should be considered according to relative participation, which, according to experts, should be linked to the total points and/or contacts played. This study contributes to developing a common metric to value the technical actions in volleyball with the purpose of measuring and comparing the performance of individual players in competition.

AUTHORS CONTRIBUTIONS

All authors collaborated in the design and regular review of the manuscript. CLS was the main responsible for the writing and execution of the study. MPM wrote the results and part of the statistical analysis, DML contributed the translation and statistical analysis and JJM drafted the abstract and supervised the conclusions.

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